Use Attainability Analysis

Blackbird Creek

Lemhi County Idaho

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CONTENTS

1. INTRODUCTION

A use attainability analysis (UAA) is a process under the Clean Water Act to help achieve the act's goal of maintaining and restoring the physical, chemical, and biological integrity of our waters. Use attainability analyses are required by the Clean Water Act whenever a State designates uses for a water body that do not include the "fishable-swimmable" goals of the act. These goals are:

> "...wherever attainable, provide water quality for the protection and propagation of fish, shellfish, and wildlife for recreation in and on the water...."

A UAA is a structured scientific assessment of the factors affecting the attainment of a use which may include physical, biological, and economic factors as described in 40 CFR 131.10(g). The §131.10(g) factors include:

(1) Naturally occurring pollution concentrations prevent the attainment of the use; or

(2) Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met or

(3) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or

(4) Dams, diversions, or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in way that would result in the attainment of the use; or

(5) Physical conditions related to the natural features of the water body such as lack of proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude the attainment of aquatic life protection uses; or

(6) Controls more stringent than those required by §301(b) and §306 of the Act would result in substantial and widespread economic and social hardship.

In the preamble to EPA's 1983 water quality standards regulations[1], a UAA is further defined as containing a water body survey and assessment, a waste load allocation, and economic analysis, if appropriate. A water body survey and assessment evaluates the physical, chemical, and biological characteristics of a water body to define its existing uses. A waste allocation uses mathematical models to predict the amount of reduction necessary in pollutant loadings to achieve a given concentration, such as a water quality standard. An economic analysis is used in

[1] 48 FR 51401

determining whether more stringent requirements would cause substantial and widespread economic and social impacts disproportionate to benefits.

According to draft guidance from EPA' Region 10, depending upon the circumstances a UAA may be simple or may need to be an extensive analysis. The present UAA is relatively complex due to the following factors: (1) contamination results from both natural and human sources; (2) detailed studies have been conducted to determine the effects and sources of contamination, and necessary allocations (reductions) needed to restore water quality, and on the feasibilty of sucessfully acheiving those allocations.

Idaho Code Section 39-3604 requires uses to be designated for waters taking into consideration such physical, geological, chemical, and biological measures as may affect the surface waters. Waters which have uses which exist or have existed after November 28, 1975 (the effective date of the Clean Water Act) are to be protected. The Idaho Division of Environmental Quality (DEQ) has developed a structured evaluation processes for documenting the existence and status of protected uses of waters (IDEQ undated, 1996).

The following analysis for Blackbird Creek describes results of water body surveys and assessments conducted from the 1960s to date, geotechnical and engineering investigations conducted to determine the feasibility of remedying pollution problems in the Blackbird Creek watershed, and mathematical models predicting what reductions in pollutant loading and benefits in water quality would occur following implementation of a range of different feasible remedial alternatives[2]. There are six stream segments in the Blackbird Mine vicinity which do not meet the goals of the Clean Water Act due at least in part to metals pollution from the mining activities: Blackbird Creek, Meadow Creek, Bucktail Creek, the South Fork of Big Deer Creek, Big Deer Creek, and Panther Creek below the confluence with Blackbird Creek. This analysis only considers Blackbird Creek, since its use designations are the subject of a proposed rulemaking.

2. Watershed Description and History

Blackbird Creek, is a tributary to Panther Creek in the Middle Salmon-Panther subbasin of the Salmon River basin (HUC 17060203). It is a second-order, perennial stream originating in the forested Salmon River Mountains in east-central Idaho, flowing southeast for about nine miles to its confluence with Panther Creek (Figure 1). A tributary, Meadow Creek, originates and drains through the inactive Blackbird Mine. Blackbird Creek has received dissolved heavy metals loading from acid mine drainage originating from exposed sulfide containing ore and waste rock at the mine, as well as historic mine waste disposal directly into the creek.

The Blackbird cobalt and copper mine is located on one of the largest cobalt deposits in North America. The primary sulfide ores are a cobalt-arsenic sulfide called cobaltite ($CoAsS$), chalcopyrite ($CuFeS_2$),, pyrite (FeS_2), and pyrrotite (FeS). Mining began in the late 1890s and continued intermittently until 1982. The mine has about 15 miles of underground workings (12

[2] Under CERCLA ("Superfund") Natural Resource Damage Assessment (NRDA), EPA Superfund, and Clean Water Act programs, words like "restoration," "remedial," "feasibility," and "attainable" have taken on specific legalistic meanings. Legal meanings are not used here; their meanings and usage follow standard written English.

levels with 8 portals), a 14 acre open pit, and, prior to cleanup, about 85 acres of exposed metals-contaminated mine waste.

Some of the earliest reports (circa 1930) on mining in the area suggest that all mine tailings were channeled directly into Blackbird Creek (Reiser 1986). Settling ponds and tailings pipelines were subsequently constructed in the 1940s and 1950s. These containment methods frequently failed with periodic spills of tailings going unchecked into Blackbird and, ultimately, Panther Creek. Open-pit mining began in about 1954 in the Big Deer drainage, resulting in contaminated mine drainage entering Panther Creek via Big Deer and Bucktail creeks (Reiser 1986).

Welsh et al. (1965) described the mining activity as follows:

> "[In Panther Creek] above Blackbird Creek, no stream pollution exists. From 1948 to 1961, a mine located at the head of Blackbird Creek employed a floatation process for ore separation. A number of reagents were used, including sodium sulfide, sulfuric acid, and pine oil. The effluent was then run into a settling pond where the sediment dropped out. During the winter the pond would freeze and sediment escaped into Blackbird Creek and Panther Creek. Unless lime was added at the settling pond, the water in Blackbird Creek was highly acidic. After entering Panther Creek, the acidity was dissipated by neutral water and a heavy reddish precipitate which persisted for about 10 miles formed on the bottom of the stream."

In 1983, the Idaho Attorney General filed suit against current and past owners of the mine to recover of damages for injuries to natural resources caused by releases of hazardous substances from the Blackbird Mine. In 1993, the U.S. Department of Justice also filed suit on behalf of the Forest Service, the National Oceanic and Atmospheric Administration (NOAA), and the EPA seeking compensation for natural resource and other environmental damages. In 1995, the suits were settled. In lieu of paying damages for the natural resource trustee agencies to restore the site, the responsible parties agreed to restore water quality and biota in Panther Creek below the confluence of Blackbird Creek to levels capable of supporting all life stages of anadromous and resident salmonids, and to restore water quality and aquatic biota in Big Deer Creek below the confluence to levels capable of supporting all life stages of resident salmonids. Blackbird Creek, Meadow Creek, Bucktail Creek, and the South Fork of Big Deer Creek were not required to be restored due to consensus reached during settlement negotiations that their full restoration (i.e. meet water quality standards) was technically infeasible. A "Biological Restoration and Compensation Program" of additional habitat improvements in and beyond the Panther Creek basin, and chinook salmon restocking was agreed to in order to mitigate for the loss of salmon and salmon habitat over the years that these services were injured by pollution from the mine. No specific mitigation or compensation was included for the impairment of Blackbird Creek, or the other creeks which supported only resident trout, not salmon[3].

[3] *State of Idaho et al. v. The M.A. Hanna Company, et al*. United States District Court (Idaho), Consolidated Case No. 83-4149 (R). 1995 Consent Decree

In 1995, engineering design and construction of facilities to restore water quality in Panther and Big Deer Creeks began. Construction of most facilities should be completed by fall of 1998. This phase will be followed by three years of monitoring the attenuation and stabilization of areas disturbed by the remedial construction, and further evaluations and iterative cleanups of remaining sources. Water quality is expected to be fully restored in Big Deer Creek and Panther Creek by 2002. Overall costs of actions to improve water quality, operations and maintenance of facilities for improving water quality, and other stream quality improvements, relating to the Blackbird Mine site restoration are projected to be about $65 million.

3. Surface Water Chemistry

Over 30 years of monitoring have shown that Blackbird Creek contains greatly elevated concentrations of copper and cobalt. Since (1) cobalt has no national or state numerical standard but would be considered a “deleterious substance” at excessive concentrations, whereas copper has published numerical standards; and (2) copper and cobalt have been shown to generally co-vary in Blackbird Creek; for the purpose of evaluating attainable uses, the further analysis focuses only on copper as if it were a single pollutant even though what actually occurs is a copper-cobalt mixture.

a. Historical trends

Surface water chemistry in Blackbird Creek was systematically studied by Forest Service and University of Idaho researchers from 1967 through 1976. Their results showed Blackbird Creek during this time was consistently was acidic (3 - 6 pH) with greatly elevated copper and cobalt concentrations. During 14 sampling events from July 1974 to September 1975, total copper[4] concentrations ranged from about 1,200 to 5,600 µg/l (Figure A-1). The current standard for copper is about 12 µg/l.

b. Recent conditions

Surface water chemistry in Blackbird Creek was studied extensively from 1993-1995 as part of investigations of the nature and extent of contamination and for restoration analyses. During high flows in 1993, dissolved copper concentrations in Blackbird Creek were up to 550 times greater than the acute water quality standard for copper; during low flow copper concentrations exceeded the standards by about 10 times. Excerpts from surface water data reports are presented in Appendix A, as well as in the inputs to water quality models used to predict residual copper concentrations after restoration (Appendices H and I).

c. Naturally occurring pollution concentrations

In order to realistically evaluate monitoring data, attainable uses, and develop plans for remediation, naturally occurring pollution concentrations need to be considered. Blackbird Creek drains an area where elevated copper and cobalt concentrations occur in the soil and rock; that is why the mine was located there. Through natural weathering, metals are leached from mineralized areas into streams, a process called acid rock drainage. However, by disturbing these areas through mining, the acid rock drainage phenomena is greatly accelerated. To evaluate whether metals concentrations in stream are primarily natural or a human-caused, it is necessary to evaluate undisturbed areas with similar mineralization or pre-mining conditions. These evaluations are by necessity imperfect: historical data is sketchy, and other undisturbed reference areas will presumably have less extensive mineralization than where the mine was developed (otherwise the mine would presumably have been developed elsewhere).

In 1993, surface water from small streams and springs from undisturbed mineralized areas were sampled and compared to similar waters in the Blackbird drainage (Hagler Bailly 1994). Mebane (1994) compiled historical sediment water chemistry data from undisturbed and disturbed highly mineralized areas in the vicinity. Both studies found that metals concentrations

[4] Measured as total recoverable copper

in the mineralized and disturbed Blackbird drainage are much higher than in mineralized and undisturbed areas. Thus, although metals concentrations in the Blackbird drainage would have been naturally higher than other non-mineralized drainages, the extent and severity of metals pollution in the Blackbird drainage were greatly exacerbated by mining related disturbances.

4. Biological Conditions

Numerous surveys of fish and macroinvertebrates have been conducted on Panther Creek, in order to assess the effects of the Blackbird drainage. While Blackbird has been extensively chemically characterized, lack of aquatic life in lower Blackbird Creek has largely been a foregone conclusion and relatively few biological surveys of Blackbird Creek in order to confirm the obvious have been conducted. Access to roadless upper Blackbird Creek probably discouraged sampling the reaches above the mine drainage.

a. Macroinvertebrates

Robinson and Minshall (1995) collected macroinvertebrates from Blackbird Creek above and below Meadow Creek as part of a study to develop community metrics that could discriminate reference and impaired biological conditions in different ecoregions of Idaho. They reported that above Meadow Creek, the macroinvertebrate community was diverse and abundant and had strong representation by the generally sensitive Ephemeroptera, Plecoptera, and Trichoptera orders (mayflies, stoneflies and caddisflies). Blackbird Creek below Meadow Creek was nearly devoid of macroinvertebrates.

In 1995, as part of DEQ's beneficial use reconnaissance program (BURP), two sites on Blackbird Creek below the mine drainage were sampled. Both sites had among the lowest abundances of macroinvertebrates found in about six hundred sites sampled in Eastern Idaho.

Hagler Bailly and CSU (1994) sampled lower Blackbird Creek as part of a study to assess effects of mine drainage on macroinvertebrate communities in the Panther Creek watershed. They reported the creek was nearly devoid of life with biomass in Blackbird Creek about 1% that of controls. Orthoclad chironomids, a group which typically thrives in metals polluted waters, dominated what life was present; however, even this population was severely depressed.

Excerpts from these reports are enclosed in appendix C.

b. Fish

Four reports of quantitative fish surveys on Blackbird Creek were located. Corley (1967) electrofished lower Blackbird Creek, finding no fish. Sgro et al. (1981) electrofished lower Blackbird Creek, finding no fish. Robinson and Minshall (1995) electrofished Blackbird Creek above Meadow Creek finding an isolated population of Westslope cutthroat trout (100% of the fish captured were Westslope cutthroats); no fish were found in lower Blackbird Creek. In 1997, IDEQ electrofished the two sites below Meadow Creek where macroinvertebrates and physical aquatic and riparian conditions were also characterized. No fish were captured (Appendix D).

In 1985 and 1993, caged trout were placed in Blackbird Creek at its mouth to test for acute toxicity to fish. Conditions were acutely lethal, all of the fish died within 24 hours in both tests (Appendix E).

5. Physical Habitat Conditions

Physical conditions related to the natural features of Blackbird Creek have not been as thoroughly studied as chemical conditions, since copper contamination has long been considered the limiting factor both on Blackbird and Panther Creeks. Since Blackbird Creek upstream of Meadow Creek supports cutthroat trout, the West Fork of Blackbird Creek above the tailings impoundment supports an isolated population of bull trout, and nearby streams with similar geomorphology and elevation support fish, there are no apparent inherant natural physical habitat limitations that would preclude fish use. In 1995, DEQ crews surveyed habitat conditions at two reaches of Blackbird Creek: one near the mouth, and one a short distance below the mine. Both sites had been disturbed by past mining practices. The surveys include measures of substrate, geomorphological, and fish refugia microhabitat characteristics. Relative to other wadable streams in the Northern Rockies ecoregion, the habitat conditions at the upper site precluded "full support" of aquatic life, conditions at the lower site, while less than optimal, would not preclude aquatic life use.

6. Recreational Uses

"Secondary contact recreation," is recreation on or near the water body where incidental ingestion of water is unlikely, such as consumption of fish from the water body, fishing, or wading. This is the default use classification for streams too small to swim in. This classification is probably the most appropriate of the available use classifications. Much of Blackbird Creek is on public lands administered by the Salmon/Challis National Forest. The Panther Creek road, a well traveled Forest Service road, crosses Blackbird near its mouth. A bar is located adjacent to the creek at its mouth. The numeric water criteria for secondary contact recreation do not relate well to likely exposures from Blackbird Creek. Some criteria, such as arsenic, are set at low concentrations due to assumptions of bioaccumulation factors in fish, fish consumption, and thus, a human dose of the substance. Since Blackbird has no fish, that exposure pathway does not exist. Developing site specific exposure factors and recreation based site specific water quality may be appropriate.

7. Feasibility of remedying pollution sources

Three major engineering studies have been conducted to examine alternatives for reducing metals pollution from the Blackbird watershed. (1) Bechtel was retained by the Bonneville Power Administration in 1984 to develop rehabilitation measures for Panther Creek as part of their programs to mitigate damages to salmon and steelhead runs; (2) Rocky Mountain Consultants were retained in 1994 by NOAA, the Forest Service, and the State of Idaho in support of their litigation to estimate and recover damages in order to restore the water quality in streams affected by the mine; and (3) Golder Associates were retained in 1994 by the Blackbird Mine Site Group to analyze alternatives for restoring water quality in Panther Creek.

a. Bechtel 1986

In 1984 and 1985 Bechtel investigated sources of copper loading Blackbird Creek and proposed measures to reduce loading to Panther Creek. They estimated that implementing their recommended alternative would reduce dissolved copper concentrations in Panther Creek below Blackbird Creek to about 10 to 20 μg/l (Reiser 1986). While their calculations were not reported, assuming a 10:1 Panther to Blackbird flow ratio (based on 1993 - 1995 base flows), estimated dissolved copper concentrations in Blackbird Creek at the mouth would be about 100 - 200 μg/l. None of Bechtel's proposals were implemented due in part to the litigation at the time between the State of Idaho and the Blackbird Mine's owners.

b. Rocky Mountain Consultants 1995

Rocky Mountain Consultants is a engineering firm that is experienced in the evaluation and remediation of water quality problems relating to mining activities. RMC was tasked to estimate the costs of water quality restoration by analyzing site conditions and developing alternatives for restoration. RMC developed and evaluated the effectiveness of three alternate approaches for restoring water quality. All alternatives involved different configurations using four main methods:

> (1) Preventing clean run on water from coming into contact with mine waste;
> (2) Collecting and treating run off water that is contaminated from contact with mine waste;
> (3) Upgrading the capacity and efficiency of the existing water treatment plant; and
> (4) Excavating mine waste (including dredging contaminated sediments) and relocating to a repository.

RMC developed two "Intensive Restoration" alternatives that met the restoration feasibility criteria[5] and would fully restore water quality in Panther Creek by addressing all significant contamination sources. They also evaluated the effectiveness of a "Partial Restoration" alternative that was being considered for implementation as an interim measure (Appendix F and RMC 1995). RMC estimated the effectiveness of each component of these alternatives at reducing contaminant loading from all identified point and nonpoint sources of loading. They then predicted the resulting downstream concentrations through the Water Analysis Simulation Program (WASP), a geochemical contaminant transport model developed by EPA.

The modeling predicted that the two "Intensive Restoration" alternatives would be successful at restoring chemical water quality in Panther Creek to levels which would support all life stages of resident and anadromous fish. However, even with their best case estimate of 90% reduction in copper concentration for their preferred "intensive restoration" alternative, under high flow conditions, copper concentrations in Blackbird Creek would still range from around 24 to 590 μg/l. These concentrations would exceed the Contaminant Maximum Concentration copper standard of about 12 μg/l by 2 to 50 times.

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[5] Criteria for NRDA restoration analysis include technical feasibility, relationship of cost to benefits, cost effectiveness, potential for natural recovery, health and safety, and compliance with applicable federal and state laws (43 CFR 11.82 (d) (1-10)).

The effectiveness of dredging contaminated sediments from the Blackbird Creek channel may be limited due to the extent of contamination to the alluvium. Test pits dug in 1994 into alluvial material in lower Blackbird Creek showed no decrease in copper, cobalt, and arsenic sediment contamination at depths in excess of 12 feet. Consequently, wholesale dredging sediments in Blackbird Creek bears a risk of worsening water quality by exposing a fresh reservoir of contamination.

When the 12-year lawsuit over restoring water quality downstream of the Blackbird Mine was resolved in 1995, the settling defendants opted to restore the water quality themselves using their own contractors rather than paying damages to the natural resource trustee agencies to implement the restoration. However as described in the following section, the restoration that actually is being implemented shares features with the alternatives RMC developed. Consequently, the conclusions from their predictive modeling which as based upon the general assessment of feasible long term load reductions (Table 4-5 in Appendix F) is still relevant to the question of what overall water quality conditions may be expected for different streams receiving contaminant loading from the mine.

c. Golder Associates 1995-1997

The settling defendants, the Blackbird Mine Site Group, selected Golder Associates as the prime contractor to direct further characterization of site conditions, engineering design, construction of facilities, and to manage the overall project. Golder Associates is an engineering firm that is experienced in the evaluation and remediation of water quality problems relating to mining activities.

In 1995, Golder prepared an analysis of alternate designs for "Early Actions" to restore water quality to levels supporting all life stages of salmonids in Big Deer and Panther creeks (Appendix G). Their recommended alternative has been iteratively refined as site conditions are progressively better defined. As did RMC, Golder considered various configurations of the four major approaches to improving water quality from the site (described above).

Golder has prepared a series of three analyses of alternatives (AOAs) for restoring water quality at the site. In the original AOA, Golder (1995) developed eight alternative facilities configurations to address primary sources of metals contamination from waste rock piles and tailings the Bucktail and Meadow Creek drainages and from mine discharges. The two supplemental analyses of alternatives were focused on much narrower scopes, "AOA SUP-1" compared benefits of waste rock removal and capping in lower Meadow Creek below a the section to be dammed, and "AOA SUP-2" evaluated alternate configurations for facilities in the Bucktail drainage. To date, Golder Associates have produced about 48 final documents relating to actions to improve water quality (Scheuering, pers. comm).

8. Restoration Progress

The Blackbird Creek portion of the overall restoration project is progressing in two major phases:

I. <u>Early Actions</u> consist of measures that could be designed and constructed relatively quickly (two to four year time frame). Design of the "early actions" began in 1995; construction is projected to be mostly completed by late 1998. Major features under construction affecting the Blackbird Creek watershed include:

a. Clean water diversion ditches to intercept uncontaminated small drainages and sheet runoff and divert them around mine waste rock;

b. Construction of a dam at 7100 feet on Meadow Creek to collect contaminated surface and subsurface flows for treatment;

c. Capping contaminated areas in the Meadow Creek valley below the Meadow Creek dam; and

d. Upgrading the capacity of an existing water treatment plant to treat all collected contaminated water from the mine area[6].

Figure 3, taken from "AOA-SUPP-2," shows the selected layout of facilities that are under construction. The overall cost of the Early Action phase of the project for design, construction, operations and maintenance, and oversight is currently projected to be approximately $33 million (Scheuering, pers. comm.).

II. Remedial actions are potential measures that cannot be implemented until after completion of the "early actions". These include monitoring the effectiveness of the "early actions" and natural attenuation of contaminated sediments downstream of the mine, and identifying and remedying relatively minor contamination sources which may currently be masked by the major uncontrolled copper and cobalt loads coming from the Meadow Creek drainage. These are planned from 1999 to 2002.

a. Estimated effectiveness of actions

Using simple mass balance accounting, Golder (1997) estimated post early action copper and cobalt concentrations in Blackbird Creek. Assuming that the cleanup of the mine site would be 100 percent effective, Golder calculated the residual fractions of the copper and cobalt loads that result from leaching or desorption from sediments or other nonpoint sources along the lower Blackbird Creek channel. Post early action cleanup dissolved copper concentration estimates at the downstream end of Blackbird Creek range from 52 to 332 µg/l. These may be best case estimates since actual effectiveness cannot achieve 100 percent effectiveness[7].

In addition to the mass balance accounting, some of the geochemical modeling is useful for estimating future conditions in Blackbird Creek. The layout of components in the Meadow/Blackbird portion of RMC's "Intensive Restoration Alternative 2" are similar to the project that is actually being constructed. Thus the load reduction assumptions used for the predictive modeling are probably reasonable estimates for the current project. Using these

[6] The existing plant was constructed in 1980 to only treat discharges from the lowest mine portal which were considered "point source" discharges and contributed about 10 percent of the overall metals loading to Blackbird Creek.

[7] The point source discharge of treated mine water from the water treatment plant will at times dominate the segment of Blackbird Creek from the discharge to the confluence of West Fork of Blackbird Creek. Historically, effluent from the water treatment plant contained around 80 µg/l total copper.

assumptions, and with the model calibrated to actual spring and fall 1994 conditions, during spring high-flow conditions post-project dissolved copper concentrations in Blackbird Creek would range from about 25 to 800 µg/l. Under fall low-flow conditions, copper concentrations in Blackbird Creek would range from about 3 to 26 µg/l.

9. Conclusions and Recommendations

The data reviewed support the following principal conclusions:

a. Salmonid spawning and cold water biota are not "existing uses" in lower Blackbird Creek.
b. Salmonid spawning and cold water biota are "existing uses" in upper Blackbird Creek.

Water quality conditions in Blackbird Creek above the confluence of Meadow Creek are nearly pristine and support assemblages of aquatic life typical of similarly sized streams Northern Rockies ecosystem. Water quality conditions in Blackbird Creek below the confluence of Meadow Creek are unsuitable for fish and all but the most pollution tolerant invertebrates. Blackbird Creek has been nearly devoid of aquatic life since at least the mid-1960s and remains so date.

c.. The sources of metals pollution in this segment of Blackbird Creek are principally human caused and cannot be remedied to the point of meeting criteria in the foreseeable future.

The key factor for this UAA from 40 CFR 131.10 (g)(3) is that the conditions preventing attainment of the use "cannot be remedied." Read literally, that requirement is a logical impossibility: a negative proposition can never be proven, one can only fail to disprove it. In this case, two qualified teams of geologists and engineers, each retained by clients with arguably opposite interests (plaintiffs and defendants in a tort claim), both concluded that with the current state of the civil engineering practice, Blackbird Creek could not in the foreseeable future be restored to meet or even approach meeting water quality standards for copper.

The preceding review of the physical, chemical, and biological data supports the following recommendations for appropriate use designations for Blackbird Creek:

Map Code	Waters	Salmonid Spawning	Cold Water Biota	Secondary Contact Recreation
SB-421	Blackbird Creek-source to Meadow Creek	X	X	X
SB-421X	Blackbird Creek-Meadow Creek to mouth			X

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11. Appendices

A. Water chemistry

B. Natural background pollution reports

C. Macroinvertebrate reports

D. Fish population survey reports

  D-1: Historical conditions (Corley 1967)

  D-2: Recent conditions (Robinson and Minshall 1995, IDEQ 1997)

E. Fish survival testing in Blackbird Creek

F. Physical Restoration Analysis excerpts (RMC 1995)

G. Analysis of Early Action Alternatives excerpts (Golder 1995

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I. Predicted post-cleanup water quality (Golder 1997)